



Mastercourse
Metallurgical Engineering
(Ferrous Process Metallurgy)
2008-07-31

Last name, first name:

Matrikel-Nr.:

Signature:

Task	Points (max.)	Points	Signature	Approval date	Final points (total)
1	5				
2	5				
3	5				
4	5				
5	5				
6	5				
7	5				
8	5				
9	5				
10	5				
Total:		Total after approval:			

Mastercourse

Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk

2008-07-31

1. Task: Pelletizing und Sintering

5 points

a) Please name 3 targets of iron ore preparation.

1,5 points

b) Name at least 3 components of sintering mixture!

1,5 points

c) Which binding mechanisms take place during “green pellet” production?
(at least 2 answers)

1,0 points

d) Where does sintering take place and where does pelletising usually take place?

1. at the place of iron ore mining?
2. at the place of iron ore use?

Pelletising	Sintering

1,0 points

2. Task: Metallurgical Coke

5 points

a)

1. What are the tasks of coke in the blast furnace? (at least 5 answers)

2. Which of these tasks can be fulfilled by injected substituting reduction agents? (at least 2 answers)

3,5 points

b) Name at least 2 possibilities to reduce the specific coke consumption in blast furnaces.

1,0 points

c) Which element beside carbon is mainly charged by coke into the blast furnace?

0,5 points

3. Task: Blast Furnace

5 points

a) Sketch the shaft of a blast furnace. Mark and name in this sketch the locations where burden, coke, hot blast, flue gas and hot metal are fed respectively discharged.

3,0 points

b) Where is the “cohesive zone” in the blast furnace and what happens in the “cohesive zone”?

1,0 Points

c) What are the so-called coke-windows in the blast furnace, which task do they fulfil?

1,0 points

4 Task: Thermodynamics

5 points

- a) 50 t of cooling scrap are charged into a BOF converter. Calculate the heat demand for heating up and melting the scrap.

(Assumption: the scrap consists of 100 % iron)

Given:

Charging temperature of scrap: 25°C

Final temperature of scrap: 1600°C

$c_p = 41,9 \text{ kJ/kmole}\cdot\text{K}$

Melting enthalpy: 13832 kJ/kmole

2,5 points

- b) A mixture of 80 g iron, 20 g manganese, 3 g carbon 0,5 g sulphur and 5 g silicon are molten.

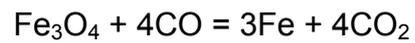
Calculate the amount of dissolved sulphur in weight-% ([S] = ... weight-%) in the melt.

1,0 points

- c) The reduction of hematite to metallic iron by use of CO as reduction gas is running about the following reactions:



Calculate ΔH_{298}° for the gross reaction:



1,5 points

5. Task: Converter

5 points

- a) How many moles of {CO} are produced in a 280 t converter, when 4,2 weight-% of [C] are oxidised?

2,0 Punkte

- b) Due to several reasons addition of lime during the BOF process is necessary. Name two of these reasons!

1,0 points

- c) Why is a high content of (FeO) in the slag necessary for effective dephosphorisation?

0,5 points

- c) Oxidation of carbon in converters can be divided into 3 phases: the starting, the main and the end decarburisation phase.

Explain in short words the decarburisation velocity in these 3 phases.

1,5 Punkte

6. Task: Direct and Smelting Reduction

5 points

a) Explain the direct reduction process (e.g. Midrex) concerning:

5,0 points

1. the input materials (at least 2 answers)

2. the reduction of the input materials

3. the reducing agents (at least 2 answers)

4. the generation of the reducing gases

5. the temperature region

6. the products (at least 2 answers)

7. the production volumes

7. Task: Electric Steelmaking

5 points

- a) Name at least 2 advantages of oxygen blowing during steel production in electric arc furnaces.

1,0 points

- b) Nowadays steel making in electric arc furnaces is mostly run by use of the so called foamy slag operation. Explain how foamy slag in EAF is generated. Give three advantages of foamy slag in EAF.

2,5 Punkte

- c) 100 tons of scrap are molten in an electric arc furnace with 120 MW electric power. The energetic efficiency of the melting process amounts 70 %. How much time is needed to melt 100 tons of scrap, assuming an energy consumption of 375 kWh per ton of scrap.

1,5 points

8 Task: Secondary Metallurgy

5 points

a) Name at least two chemical treatment methods of steel melts in ladle metallurgy.

1,0 points

b) Which secondary metallurgical processes are mostly operated under vacuum metallurgical conditions? Why? (at least 2 answers)

1,5 points

c) Give at least 2 possibilities to heat a steel melt in the ladle.

1,0 points

d) What is the Vacher-Hamilton equilibrium? Give the thermodynamical equilibrium equation and the value of the equilibrium constant at 1600°C.

1,5 points

9. Task: Continuous Casting

5 points

- a) Name the characteristic components of a continuous caster by means of a sketch.

2,5 points

- b) What is the “square-root law” of solidification? Write down the equation of this law.

1,0 points

- c) What is micro segregation? What is the reason for micro segregation?

1,0 points

- d) Give the name of the directed solidification structure growing into the melt during continuous casting (tip: the shape is similar to the shape of a fir tree “Christmas tree”).

0,5 points

10: Task: Protection of Environment, Recycling 5 points

- a) Name 3 different sorts of scrap and give a short definition or description for each of them.

3,0 points

- b) Name 4 potentials for the reduction of the specific energy consumption in steel making.

2,0 points